LETTERS TO THE EDITOR.

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To the Editor of "SCIENCE:"

PRIMITIVE STAGES OF COSMICAL EVOLUTION.

Some correspondence which has recently appeared in your columns seems to render it proper to offer a brief synopsis of my conception of the primitive modes of existence of cosmical matter. Supposing luminous cosmical matter to be intensely heated, there is no good reason for assuming this to be absolutely a first condition. It is undoubtedly a remote and primitive condition, which may be assumed as a stage from which cosmical development proceeds. But, in the light of recent science, we may reasonably seek for earlier stages at which cosmical matter existed in a cold and non-luminous state. In these stages we may conceive it either as atomically subdivided and dissociated, or as partly in a condition of molar aggregation, and perhaps of chemical combination. I am inclined to think, with Laplace and Kant, that space is abundantly stocked with cosmical matter in a crude and unformed state. I see no ground for assigning any limit to the state of subdivision in which some of it may exist. I see no satisfactory ground for assuming as Macvicar and others have done, that it emerges from an ethereal condition, nor for denying it. I do not imagine it to possess a temperature different from that of the space in which it floats—if, indeed space, which is not conditioned by matter, can be said to possess a property, which we only know as an affecton of matter.

But there is a principle of gravitation in the universe, however we may explain it, which is ever beginning the aggregation of the ultimate elements of cosmical matter, and ever uniting these aggregations into masses larger and larger. We have made the acquaintance of some of these masses, large and small, in meteoric stones and millions of meteoroids, which become kindled only by friction with our atmosphere. It has been shown that several meteoroidal trains identify themselves with well-known cometary existences. It has been suggested that a rain of cosmical matter has pelted the minute satellites of Mars until the angular orbital motion of the inner one exceeds the axial motion of the planet. The collisions of molecules and masses must result in the evolution of heat. This, within certain limits of temperature, would promote the chemical union of atoms previously dissociated. But the impact of larger masses and groups of masses and molecules would undoubtedly develop sufficient heat to vaporize matter, and even to reproduce a state of dissociation. Such events would characterize the history of any vast region of space in which cosmical atoms should have become relatively approximated. They are in process of falling together. This is the condensation of the cosmical swarm. It may proceed, as Sir William Herschel conceived, until the successive stages of nebular condensation have been passed, when the swarm arrives at the condition of a sun. But it is well-nigh impossible for two cosmical masses to come together without producing rotation. The constituent portions of a nebula must probably rotate, and the nebula as a whole must, in most cases, exist in a state of rotation. Such a nebula was the starting point of Laplace, and was recognized as an actual contingency by Sir William Herschel.

But I do not conceive a fully formed and characteristic nebula as necessarily in a state of complete gaseity. The perpetual collision of hard parts might vaporize sufficient matter to occupy the intervening spaces and afford the characteristic spectral results.

As long as the nebula remains in process of condensation through central gravitation, the evolution of heat must continue. But there is a juncture at which rise of temperature must cease. That is reached when the elastic forces equilibrate the attractive. From this point, condensation developes heat, but some more is lost than is acquired, and the mass continually subsides in temperature. It is only the loss of an excess of heat which now permits the progressing condensation. Cooling is the limiting condition of condensation; and to assert a rising or a constant temperature is to assume that a condition may be surpassed by the effect of that which it conditions and measures. It is a virtual denial of the conservation of energy and of the equation of cause and effect.

In this view of cosmical beginnings, nebular heat is preceded by motion, and the cause of motion is what we call gravity. If, as Le Sage maintained, gravity is only the effect of the impact of a storm of ultramundane corpuscles, then our explanation ends at last in motion for which we cannot invoke gravity as an ultimate physical cause. Metaphysically speaking, such must be the issue of all explanations. There is a necessary *ultima thule* in the realm of thought. We are no nearer an absolute explanation at one stage of cosmical development than at any other The remotest term reached must always stand scientifically unexplained.

I began by supposing luminous nebular matter intensely heated. There are many indications that such is its condition. The bright spectral lines and the analogy of the envelopes of the solar and stellar bodies are strongly suggestive. The rational continuity of cosmical development, leading our thoughts backward from an incrusted world through all conceivable stages, to an incandescent vapor or possibly gas, enforces the conviction of high nebular temperature. But, on the contrary, the very limited number of nebular bright lines spectroscopically revealed proclaims a fundamental condition widely different from that in the sun and fixed stars. It might be suggested that this indicates not only elemental dissociation, but an ulterior resolution, as Lockyer maintains, into one or two sole sorts of world-stuff; but it may also be suggested that the phenomenon is so divergent from the results of any terrestrial verifications that we are left without any substantial ground for inference. The nuclei of comets give also a few bright spectral lines. When the comet is near its perihelion it is not difficult to admit, in some cases, that the spectrum reveals a volatilized condition; but when a body so tenuous as to transmit star-light has retired from perihelion, it is difficult to believe that a gaseous condition is still the effect of high incandescence. The identification of cometary and cold meteoroidal trains, if it has truly been done, throws doubt on the assumed heat of even the nuclear portions of a comet remote from the sun; and yet even here it is supposable that perpetual collision of cold hard parts disengages sufficient heat to create a common gaseous medium. Finally, the meteoric streak of light left sometimes fifteen to thirty minutes after the fall and dissipation of the meteor, cannot be a case of heated luminosity. Heat vaporizes the meteoroid; but it is then a train of minutely divided particles exposed to almost instantaneous refrigeration. A few grains of matter strewn along a path twenty miles in extent, in the cold atmosphere, cannot retain luminosity as a consequence of high temperature. We might cite the streamers of the *aurora borealis*, and the Geisslerian discharges, and Crooke's radiant matter, and the general phenomena of phosphorescence as further reminders that intense heat is not the only cause of luminosity, and suggestions that nebular light *may* not be exclusively the light of thermal incandescence.

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